



Native Aquatic Species Vulnerability Index

This EnviroAtlas national map displays a measure of the overall vulnerability of the native aquatic animal species (including fish, amphibians, crayfish, mollusks, and turtles) present within each 12-digit hydrologic unit (HUC) across the conterminous United States (all states excluding Alaska, Hawaii, and island territories). These numbers are based on species range data drawn from publicly accessible databases.

Why is native aquatic biodiversity important?

Freshwater biodiversity is the foundation for a wide variety of ecosystem services.¹ The most obvious of these services include things like fish production and recreational opportunities. But freshwater biodiversity also provides us with clean and clear water, nutrient transport, pollution control, flood mitigation, and a range of other valuable services. In the US and around the globe freshwater habitats support a disproportionate share of the world's plant and animal biodiversity.

Growing demands by human populations for services derived from freshwater ecosystems has put enormous strain on these resources and resulted in troubling declines in native freshwater diversity.² Stressors to that diversity include over-extraction (e.g. overfishing), habitat loss or modification (e.g. loss of wetlands or construction of dams), chemical pollution, and the introduction and spread of invasive species. These stressors have been associated with declines in biodiversity in all types of ecosystems, but freshwater habitats may be particularly susceptible.

As a result of these stresses, freshwater biodiversity is currently under threat in the US and throughout the world, with high rates of species loss in many places across the globe.³ Conservation of this diversity is critically important not only to prevent future extinctions but also to preserve the ecosystem services that these species provide to humans.

The United States, in particular, boasts an incredibly diverse freshwater fauna and is home to some of world's greatest freshwater biodiversity hotspots.⁴ For instance, the Appalachian region in the Southeastern US is the center of US freshwater diversity and is widely recognized as a global hotspot for multiple groups including fish, amphibians, and invertebrates. Many of the species found here are found nowhere else in the world, some have extraordinarily limited native ranges (such as the Shenandoah salamander pictured above, which is known from only three mountains in



Photo: Shenandoah Salamander, Ryan Hagerty, USFWS

Shenandoah National Park in Virginia), and many are threatened or endangered. Understanding where such hotspots are and how they are threatened can provide essential information to anyone interested in protecting this unique biological heritage.

How can I use this information?

The EnviroAtlas national map, Native Aquatic Species Vulnerability, illustrates a measure of the overall vulnerability of native aquatic animal species across the conterminous United States summarized by 12-digit HUC. The Vulnerability Index for a watershed is a normalized average of two metrics, the Rarity Index (which assesses the average rarity of the species in a watershed based on their ranges across the U.S., with small range species being considered rare) and the count of threatened and endangered species in the watershed.

This map can be used to identify areas where native biodiversity may be particularly vulnerable. In some cases, watersheds may harbor large numbers of threatened and endangered species. Or they may be home to very rare species, some of which have ranges limited to only one or very few watersheds; losses in those watersheds could represent dramatic declines in the overall populations of those species. This map therefore can be used to identify areas that may be candidates for prioritizing the protection of freshwater biodiversity. Used in conjunction with other data layers available in EnviroAtlas, this map can also help us to understand where rare freshwater animal diversity is currently most threatened by stressors like pollution, habitat loss, and invasive species.

How were the data for this map created?

Data on native aquatic species occurrences were drawn from the International Union for Conservation of Nature's (IUCN) [Red List spatial database](#) (data downloaded in May, 2016). The species ranges published by the IUCN were allocated to watersheds using Geographic Information Systems tools. Our database contains 1510 species, including fish, mollusks, amphibians, turtles, and crustaceans (shrimp and crayfish).

The Vulnerability Index was calculated as a normalized average of two other metrics included in EnviroAtlas: *Native Aquatic Species Rarity* and *Number of vulnerable native aquatic species based on IUCN range*. To learn more about how the database was assembled and how metrics were calculated, please see the [metadata](#), or the 2018 paper by Panlasigui, et al.⁵

What are the limitations of these data?

EnviroAtlas uses the best data available, but there are still limitations associated with these data. The non-native aquatic species richness data are drawn from existing datasets developed and maintained by IUCN. Unfortunately, these data represent an incomplete account of aquatic animal diversity. There is extremely limited data availability for some taxonomic groups (so many species are missing), and others are absent from the dataset entirely (e.g. certain groups of aquatic invertebrates). Some of these missing taxa may play particularly important roles in providing or supporting ecosystem services. Our data also does not reflect population density or other measures that might be relevant to

biodiversity conservation but focuses only on the likely presence of a species in a watershed.

IUCN species ranges are determined based on both species observations and on models of habitat suitability. They therefore represent an estimate of the distribution of a species and should not be taken as absolute measures of species occurrence.

How can I access these data?

EnviroAtlas data can be viewed in the [Interactive Map](#), accessed through [web services](#), or [downloaded](#).

Where can I get more information?

More information on the value of freshwater biodiversity and the services it supports can be found in the Millennium Ecosystem Assessment ([Chapter 7](#)), at [IUCN](#), and through the Food and Agriculture Organization of the United Nations ([FAO](#)). More on hotspots of freshwater diversity within the US can be found through the National Fish and Wildlife Foundation.

Acknowledgments

EnviroAtlas is a collaborative effort led by EPA. The data for Native Aquatic Species Richness were derived from data originally developed and curated by IUCN. Stephanie Panlasigui, ORISE Participant at the USEPA, created the data layer. John Darling, EPA, created the fact sheet.

Selected Publications

1. Green, P.A., C.J. Vörösmarty, I. Harrison, T. Farrell, L. Sáenz, and B.M. Fekete. 2015. [Freshwater ecosystem services supporting humans: Pivoting from water crisis to water solutions](#). *Global Environmental Change* 34:108–118.
2. Bunn, S.E. 2016. [Grand challenge for the future of freshwater ecosystems](#). *Frontiers in Environmental Science* 4: online.
3. Dudgeon, D. 2014. [Threats to freshwater biodiversity in a changing world](#). Pages 243–253 in Freedman, B. (ed.), *Global environmental change*, Springer, Dordrecht, The Netherlands. 973 p.
4. Thieme, M.L., N. Sindorf, J. Higgins, R. Abell, J.A. Takats, R. Naidoo, and A. Barnett. 2016. [Freshwater conservation potential of protected areas in the Tennessee and Cumberland River Basins, USA](#). *Aquatic Conservation: Marine and Freshwater Ecosystems* 26:60–77.
5. Panlasigui, S., A.J.S. Davis, M.J. Mangiante, and J.A. Darling. 2018. [Assessing threats of non-native species to native freshwater biodiversity: Conservation priorities for the United States](#). *Biological Conservation* 224: 199–208.